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What's mine is a hologram? How shared Augmented Reality augments psychological ownership.

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Abstract

Augmented Reality (AR) holograms are 3D digital objects projected into a customer's physical environment through mobile technology. Applied as potential substitutes to physical products, AR holograms pose a unique challenge for conventional configurations of product ownership. Taking a socially situated cognition perspective, we demonstrate how customers' shared experience of AR holograms leads to distinct perspectives on psychological ownership. In Study 1, we demonstrate how customisation of AR holograms lets customers feel psychological ownership of digital products. In Study 2, we highlight the mechanisms of social adaptation related to assimilation and differentiation that drive the relationship between customisation and psychological ownership of AR holograms in social settings. In Study 3, we illustrate how these mechanisms are influenced by the affordances of AR technology when customers switch between personal or shared devices. We discuss implications for theory and marketing practice of this potentially novel class of digital consumer products.

Keywords: augmented reality, psychological ownership, customisation, situated social cognition, social identity

INTRODUCTION

Imagine a 70-inch TV set in your home. Now imagine an Augmented Reality (AR) hologram of that TV set, visually indistinguishable from its physical counterpart with superior convenience at a fraction of the cost. Is it possible for you to feel the same sense of ownership over the hologram as you feel over the physical product? Would your friends and family feel the same? Answering such questions becomes increasingly important as AR technology enables marketers to provide their customers with holograms that emulate functions of physical products (Porter and Heppelmann, 2017). An AR hologram is an interactive digital object projected into a customer's real-time experience of the physical environment (Scholz and Smith, 2016). Viewed through a device, such as Microsoft's HoloLens, a customer sees AR holograms like the AR TV set, or a decorative statue or model car situated on a cabinet in her living room. Using the HoloLens version of Skype, for instance, she can watch films on the hologram TV as she would be using a physical screen; and opening a suite of software options she can instantly change the colour, shape, and position of AR decorations in her room. She does this with hand gestures, and with more than one HoloLens she shares a live view of her personal holograms with others.

Applications like Apple's ARKit enable customers to scan physical objects into AR holograms, modify their digital attributes, and retain them in a physical environment for others to interact with (Engadget, 2018; Apple Newsroom, 2018). AR holograms may let customers feel like they own more than just a digital copy of a physical product, as they can freely modify the product within their personal environments and engage in shared customisation of the product with others (Hilken et al., 2018). With AR, changing the look and feel of the wall colour (e.g., Dulux, 2018) and decorative pieces in one's home becomes a matter of mood, time of day, or social occasion. The ease of modifying digital attributes and sharing AR holograms in social settings creates a shared experience "beyond [the] ordinary

range of perception", which according to Alex Kipman, the creator of Microsoft's HoloLens, is the unique value proposition of this emerging technology (TED Talks, 2018).

Niantic's Pokémon Go was a catalyst for shared experiences in AR (Fortune, 2016). In a spur of enthusiasm, crowds flooded the streets to capture and own AR holograms of Pokémon critters. Customer enthusiasm to engage with such digital products is matched by industry's willingness to invest in AR. The $1.2 billion revenue that AR generated in 2016 has led to growth forecasts of up to $83 billion by 2021 (TechCrunch, 2017). Mark Zuckerberg publicly announced in April 2017 that AR is Facebook's "next big thing" (Business Insider, 2017). With Microsoft and Samsung following similar investments, AR technology is becoming ubiquitous and increasingly enables shared experience, group interaction and social identity expression (Scholz and Smith, 2016).

However, with the promise of new forms of shared experience, digitisation by AR holograms also poses a challenge for established marketing practice. In the past, digital products have proven difficult to market (Berge et al., 2015). Customers believe that digital products are inexpensive to reproduce and thus assign little conventional ownership to them, partly because modifying or sharing a digital product with others does not reduce its availability to a provider (Gulotta et al., 2013). Accordingly, AR technology is poised to redefine psychological ownership, as AR holograms subvert conventional aspects of ownership like physical scarcity or maintenance of design (Watkins et al., 2016; Bardhi et al., 2012).

Current marketing literature, however, has yet to provide an in-depth understanding of psychological ownership of AR holograms. Most research has explored interactivity, media characteristics (Javornik, 2016), and customers' intentions to use AR technology (Rauschnabel, 2018). Recently, Hilken et al., (2017) reported a sense of psychological ownership of *physical* products due to an embedded and embodied experience with AR.

Similarly, Brengman, Willems, and Kerrebroeck (2018) found an increase in customers' psychological ownership of physical products due to embodied, touch screen-based control over AR interfaces. Yet, research has not considered psychological ownership of an AR hologram itself. This critical link to the potential substitution of physical products with AR holograms remains unexplored. Moreover, as AR becomes an increasingly social technology and customers jointly interact with AR holograms (Hilken et al., 2018; Scholz and Smith, 2016), we lack knowledge about shared experience in psychological ownership of AR-based digital products. Scholars have acknowledged that psychological ownership can exist as a group-level phenomenon (Pierce and Jussila, 2011) and may foster in-group consumption (Gineikiene et al., 2017). However, a focus on shared experience and its related processes such as social identification (Scholz and Smith, 2016) that underlie the sharing of digital products is lacking.

We address this research gap and contribute to current literature by conceptualising the shared experience of AR holograms according to *socially situated cognition* theory (Bhargava and Choudhary, 2001). A key insight from this theory is that social cognition is adaptive (Semin and Smith, 2013), which implies that customers seek to align their identity with a changing social environment. This insight frames the shared experience of AR, where customers can adapt and express their identity by jointly customising holograms according to personal preferences. We argue that successful adaptation of social identity entails satisfying distinct needs for assimilation and differentiation within a group, which in the context of a shared experience of AR holograms supplants conventional forms of psychological ownership. Our contribution is twofold. First, we offer empirical evidence for a mechanism of competing social identity needs in psychological ownership of AR holograms. Secondly, we investigate which of these social identity needs drives psychological ownership when customers interact with AR holograms in a public versus a private mode. For managers, the

article transcends the role of AR as a retail channel and draws attention to AR holograms as a potentially new class of products towards which customers may feel a similar sense of ownership as for physical products. Studying such customer-relevant needs in basic research informs early design and implementation of technologies (Dietrich et al., 2017), in this case AR holograms.

The remainder of the article is structured as follows. We introduce socially situated cognition as our theoretical underpinning and discuss how it aids the understanding of the shared experience and psychological ownership of AR holograms. We describe the process of psychological ownership in relation to unique affordances, which are the actions made possible by AR holograms (Norman, 2013); namely the shared experience of customisation, social interaction, and constraints of devices and technology. In three related experiments, we investigate the effect of such affordances on psychological ownership (Study 1), the underlying cognitive mechanisms (Study 2), and how, over time, the use of AR may give rise to different paths to psychological ownership depending on the social setting in which AR is deployed (Study 3). We conclude with a discussion and implications for theory and practice.

SOCIALLY SITUATED COGNITION OF AR HOLOGRAMS

Current theorizing on socially situated cognition offers a unique framework for the conceptualisation of the shared experience of AR holograms. It holds that customers adapt to, but also rely on the resources of others (e.g., knowledge or opinion) in their social environment (Smith and Semin, 2013), for example when jointly making a decision about products (Kovacheva and Lamberton, 2018). In these contexts, a shared experience improves dyadic interaction (Vacharkulksemsuk and Fredrickson, 2012; Gineikiene et al., 2017), including rapport and performance between two people on collective tasks (Fusaroli et al., 2016). As AR holograms become physically interactive, persistent over time, and sharable

between devices (e.g., via tools like Apple's ARKit), they may enhance a shared experience amongst customers. Socially situated cognition enables us to classify the shared experience of AR holograms according to: i) embodied cognition—that is, customers can interact and use natural hand gestures to customise an AR hologram; ii) distributed cognition—that is, customers can jointly view an AR hologram; and, iii) embedded cognition—that is, customers using AR in different social settings and on different types of devices to view an AR hologram may influence their perception of that hologram (cf., Hilken et al., 2018).

Investigating these affordances, which both challenge physical notions of ownership and extend perspectives on psychological ownership to a social sphere, becomes pertinent to addressing a digitisation challenge posed by AR holograms. Socially situated cognition theorizing holds that identity is not constructed "in the mind" but through interaction with one's social environment (Semin and Smith 2013)—that is, dynamically by adapting to or distinguishing oneself from others. As such, product use or customisation serve social identification motives, as customers distribute cognition to offload their preferences and ideas onto the product. For instance, customers who use stickers, personalised plates or dolls to decorate their cars (Lee and Chen, 2011) do so to signal their identity and standing within a social group. Social standing is critical, to the point where individuals focus their attention on the shared experience. Accordingly, research has demonstrated how shared stimuli amplify memory (Eskenazi et al., 2013), heighten emotional responding (Jaremka, Gabriel, and Carvallo, 2011), and intensify goal pursuit (Carr and Walton, 2014). Expressions of shared product use or customisation allow customers to communicate their identity to a wider social context, which leads to a more intense experience of psychological ownership (Pierce and Jussila, 2011). Consequently, psychological ownership of AR holograms may stem from customers' customisation of a hologram by which they shape their identity within the immediate social environment.

PSYCHOLOGICAL OWNERSHIP AND AR CUSTOMISATION

For customers, we argue that shaping their social identity is facilitated by the ease with which they can customise an AR hologram. For example, a customer can effortlessly modify the colour, shape, or position of an AR decoration in her home for different social occasions. This challenges conventional configurations of ownership because ownership becomes divorced from physical form. Hilken et al. (2017) provide initial evidence that simulated physical control over AR holograms enhances feelings of ownership of the physical products represented by those holograms. Such embodied control also drives the "I designed it myself" effect, where empowerment creates identification with effort invested in the customisation of a product (Kirk, Swain and Gaskin, 2015). Although increased customisation activity may enable customers to more readily adapt their social identity by modifying an AR hologram to reflect their personality, recent research emphasizes that the activity of customisation itself provides customers with a sense of control over a product (Jussila et al., 2015). In turn, the ability to control an object is considered important for achieving a sense of ownership (Pierce, Kostova and Dirk, 2003). Consequently, we argue that customisation provides what we represent in our model (Figure 1) as a direct route to psychological ownership of AR holograms. We therefore hypothesise:

H1: The of customisation of an AR hologram in a given environment enhances the sense of psychological ownership of that hologram.

MEDIATION OF PSYCHOLOGICAL OWNERSHIP BY SOCIAL IDENTITY NEEDS

Another important difference between an AR hologram and a physical product is transferability. As the replication of AR holograms does not entail any cost or diminish its availability to a provider, it removes the constraints to sharing a product with others. The

exchange of AR holograms provides a shared experience that is likely to ensure acceptance within a peer group (Cooney, Gilbert, and Wilson, 2014). Sharing an experience also enables customers to distribute their thoughts about risk and uncertain goal pursuit during a novel experience (Huang et al., 2014) like that of an AR hologram.

According to socially situated cognition, a shared experience shapes a person's perception of oneness with and distinctiveness within a group (Ashforth and Mael, 1989). That is, customers rely on shared experiences to calibrate their connection to and differences from others (Huang et al., 2014). These contrasting social needs are captured in a desire to assimilate and differentiate in a social setting (Bhargave and Montgomery, 2013). Assimilation refers to inclusion within the larger collective, which stems from a desire to form interpersonal relationships (Baumeister and Leary, 1995; Sheldon and Bettencourt, 2002). A sense of belonging and social connectedness from assimilation are key factors that lead to satisfaction with ownership of virtual goods (Shen, Monge and Williams, 2014). In contrast, differentiation refers to the need for individuals to distinguish themselves from and to compete with others in a social setting (Sheldon and Bettencourt, 2002).

Uniquely, the consumption of AR holograms transcends a conventional trade-off between assimilation and differentiation. When customers use AR in a private mode, they can enhance public spaces with content that is visually unobtrusive to other users. The colour or shape of a decoration one customer sees in a room through her personal AR device can be distinct from what anyone else can see using another device. In a public mode, AR holograms offer a medium of visual communication that distributes cognition across a group and encourages assimilation. For example, by seeing decorative AR model car items in the same colour, shape and physical location, customers can synchronise their social interaction around the AR hologram. Since private and public AR modes can be applied to the same AR hologram, they uniquely encourage social adaptation through assimilation *and* differentiation.

Together the two modes result in a shared experience of an AR hologram that can be expressed as feelings of psychological ownership of that hologram. This suggests an indirect route to psychological ownership. Specifically, we hypothesise:

H2: The customisation of an AR hologram enhances social assimilation and differentiation, which in turn increase a sense of psychological ownership of that hologram.

EXPRESSION OF SOCIAL IDENTITY NEEDS BY DIFFERENT AR DEVICES

For many customers, technology-enabled shopping and consumption experiences involve collaborating with others over a certain period of time (Zhu et al. 2010). An important insight from socially situated cognition theory is that a person's cognition adapts to the dominant affordances of any situation (Semin and Smith, 2013), and accordingly research shows that customers adapt their beliefs and attitudes to an AR-enabled experience, after only relatively short durations of using the technology (i.e., when using AR for several minutes; Hopp and Gangadharbatla, 2016). Extending AR exposure, for instance in a situation when a shared device is used, implies that customers have more opportunity to discover the dominant affordances of AR technology. Specifically, Norman (2013) emphasizes the role of 'signifiers', which are the perceptual signals that suggest to customers how they should use virtual technology. A signifier can be explicit like an instruction, or implicit such as an expectation, but in effect, a signifier biases the user of a technology towards a specific style of cognitive processing. A pertinent signifier for a shared experience of AR holograms is whether customers collaborate in a private or a public mode, for example by using a personal or a shared AR device. Further, even though the customisation of AR holograms may fulfil customer needs for assimilation and differentiation simultaneously (as hypothesized in H2), we expect that as a period of AR-based collaboration extends, customers will attend more to

the pertinent affordance of the AR device (i.e., whether it is personal or shared), which determines the dominant pathway to psychological ownership.

With regards to an assimilation-dominant pathway, research emphasizes that when customers share the same point of view in a shopping or consumption experience (e.g., from sharing a device) this requires them to coordinate and achieve a common understanding of the shared experience (Brasel and Gips, 2014; Zhu et al., 2010). Achieving such common ground requires customers to synchronize their actions (Semin and Smith 2013), and thus customisation taking place over an extended period of time on a shared device should bias cognition towards assimilation. We posit that under the condition of using AR in a shared mode customers' cognitive processing is biased towards assimilation, which should take over as a driver of psychological ownership. Therefore:

H3a: For customers using a shared AR device, the need for social assimilation mediates the relationship between customisation and psychological ownership of an AR hologram.

In contrast, customers' extended use of AR in a private mode, for example from using a personal device, is likely to bias their social cognition in the opposite direction. Customers regard personal mobile devices as a medium for creating intimate relationships with firm offerings (Shankar et al., 2010). Using a personal device to interact with a digital product promotes a need for self-association with that product (Brasel and Gips, 2014). Thus, with personal AR devices, the customisation of AR holograms in social settings facilitates the expression of identity through differentiation, which we expect to then dominate as a driver of psychological ownership. Hence, we hypothesize:

H3b: For customers using a personal AR device, the need for social differentiation mediates the relationship between customisation and psychological ownership of an AR hologram.

EMPIRICAL STUDIES

We designed three experiments to sequentially test our hypotheses by extending the number of variables as illustrated in Figure 1. In Study 1, we test the proposition that AR holograms generate feelings of psychological ownership when customers are able to customise a hologram. In Study 2, we highlight the concurrent mediation of this effect through the social identity needs of assimilation and differentiation during a shared experience of customising an AR hologram. In Study 3, we explore this mediation process for customers who have a longer shared experience and investigate whether the use of a shared or a personal AR device may determine the dominant pathway to psychological ownership through either assimilation or differentiation.

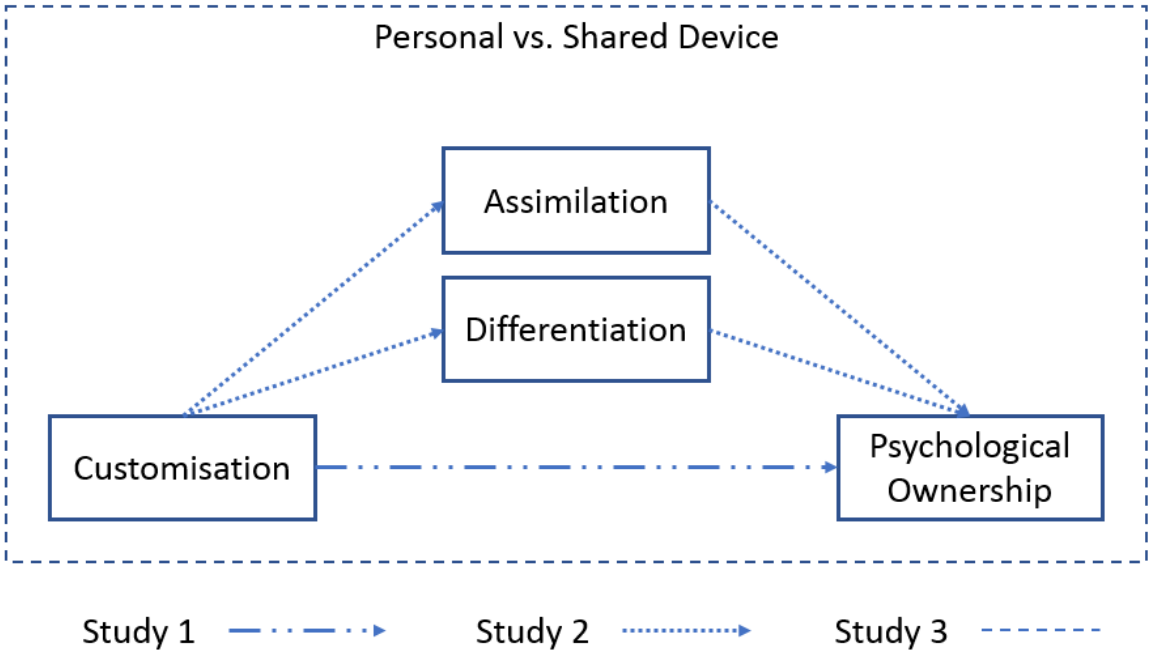

FIGURE 1. Conceptual Model

EQUIPMENT

Wearable headsets encourage seamless interaction with AR holograms. At the time of this research, the Microsoft HoloLens was the first self-contained, wearable holographic computer that allows users to embed AR holograms into their physical environments (Microsoft, 2017; see Appendix A). As the HoloLens had not been released to the wider customer market, applications with commercial products on this device were limited. Consequently, Microsoft's Holostudio was the primary software application participants interacted with during our experiments. Holostudio allows users to customise AR holograms with tools inside a virtual toolbox. Specifically, we selected a hologram of a collectable yellow truck, which replicated the functions of a physical model car customers may use to decorate an office or a room (see Appendix B). Our choice of stimulus material is in line with previous studies, where virtual cars are widely used to study digital customisation (Moehring and Froehlich, 2011; Jacobs and Froehlich, 2011). The Holostudio's toolbox provided participants with a choice of 56 colours to paint up to 68 different components of the AR truck. In addition, participants could resize the AR hologram, use full 360-degree spherical rotation, and adjust the truck's position or move it anywhere in the room. Participants controlled the HoloLens with gestures, for example by pointing to options in the Holostudio's toolbox, which were then placed on the hologram of the AR truck. In this way, we ensured that participants experienced embodied control over the customisation process.

Given the limited database of AR objects in the Microsoft's Holostudio, we also developed a secondary software application to extend the range of AR holograms in our research. The custom software application emulated functions of Microsoft's Holostudio but used a different 3D holographic image; namely, a grey hatchback passenger car. We used this new 3D holographic image to account for potential novelty effects of AR holograms when testing the complete model in Study 3.

STUDY 1

The purpose of Study 1 is to provide primary evidence for psychological ownership of AR holograms (H1) by manipulating participants' ability to customise the colour (low vs. high) and position (low vs. high) of an AR product hologram projected into the immediate physical environment.

Design and Procedure

120 undergraduate students (78 female and 42 male) between 18 and 29 years of age, completed the experiment at a dedicated laboratory in exchange for course credit. Participants were informed they would interact with AR holograms using wearable AR technology and later complete a questionnaire. Each participant was fitted with a HoloLens headset and asked to confirm that they could see the hologram of a yellow truck. In a short introduction, participants were then shown how to use the device. Participants in the high (low) colour customisation condition were (not) able to change the colour of different parts of the truck; those in the high (low) position customisation condition were (not) able to move, resize and rotate the AR truck. Participants interacted with the AR hologram for approximately five minutes. They then completed a questionnaire.

Measures

To measure the level of psychological ownership towards the AR hologram, we used an adapted 3-item measure (α = .91) by Peck and Shu (2009). Participants rated the extent to which they experienced different aspects of psychological ownership on a 7-point Likert scale ("Strongly disagree" = 1 to "Strongly agree" = 7). In view of the novel nature of the experiment, and to guard against a potential response substitution effect where participants might confound psychological ownership with their enjoyment of the customisation task (Gal and Rucker, 2011), we also controlled for affect towards the customised AR hologram. Participants responded to a 3-item measure (α = .90) by Kim et al. (1996) capturing their

affect towards the hologram after customisation with a bipolar 7-point scale (e.g., "Unpleasant" = 1 to "Pleasant" = 7). We provide an overview of all items in Appendix C.

Results

Manipulation check. We used two single-item measures to assess the success of our customisation manipulation, by which participants either changed the colour and/or position of the AR truck (Colour: "I was able to personalise the truck to suit my preference"; Position: "I had control over the truck"). Participants rated both items on a 7-point Likert scale ("Strongly disagree" = 1 to "Strongly agree" = 7). The manipulations functioned as intended for the colour (M_{High} = 5.55 vs. M_{Low} = 4.48, t(100) = -3.78, $p < 0.001$) and the position manipulation (M_{High} = 5.55 vs. M_{Low} = 4.40, t(102) = -3.76, $p < 0.001$).

Psychological ownership. We conducted a GLM analysis of the level of psychological ownership in relation to our manipulations and included affect as a covariate. In support of H1, we found statistically significant main effects of colour (M_{High} = 4.56 vs. M_{Low} = 3.60, F(1, 115) = 18.12, $p < 0.001$) and position (M_{High} = 4.39 vs. M_{Low} = 3.77, F(1, 115) = 7.70, $p = 0.006$) customisation on psychological ownership, controlling for affect (M_{Affect} = 5.64, F(1, 115) = 26.66, $p < 0.001$). Consistent with our conjecturing, participants who were able to customise—either the colour or position of—the AR hologram reported a significantly greater sense of psychological ownership compared to those who could not. There was also a significant negative interaction effect between colour and position customisation on psychological ownership (F(1, 115) = 6.70, $p = 0.011$). Investigating this effect, we note that participants who could customise both the colour and position of the AR hologram reported the highest mean psychological ownership (M = 4.58, Figure 2). However, the increase in psychological ownership was greatest when participants who could not control the AR hologram's position were provided with the ability to customise its colour (M_{High} = 4.54 vs. M_{Low} = 3.00, F(1, 115) = 23.24, $p < 0.001$); and when participants who could not

change the AR hologram's colour were provided with the ability to customise its position (M_{High} = 4.19 vs. M_{Low} = 3.00, $F(1, 115) = 14.33$, $p < 0.001$). Participants who could already customise one aspect of the AR hologram (colour or position) reported only a marginal increase in their already strong sense of psychological ownership, when provided with the ability to additionally customise the other aspect. In sum, these findings support H1, but also suggest a possible ceiling effect where each form of customisation contributes strongly to psychological ownership, and when combined the effect is only marginally increased.

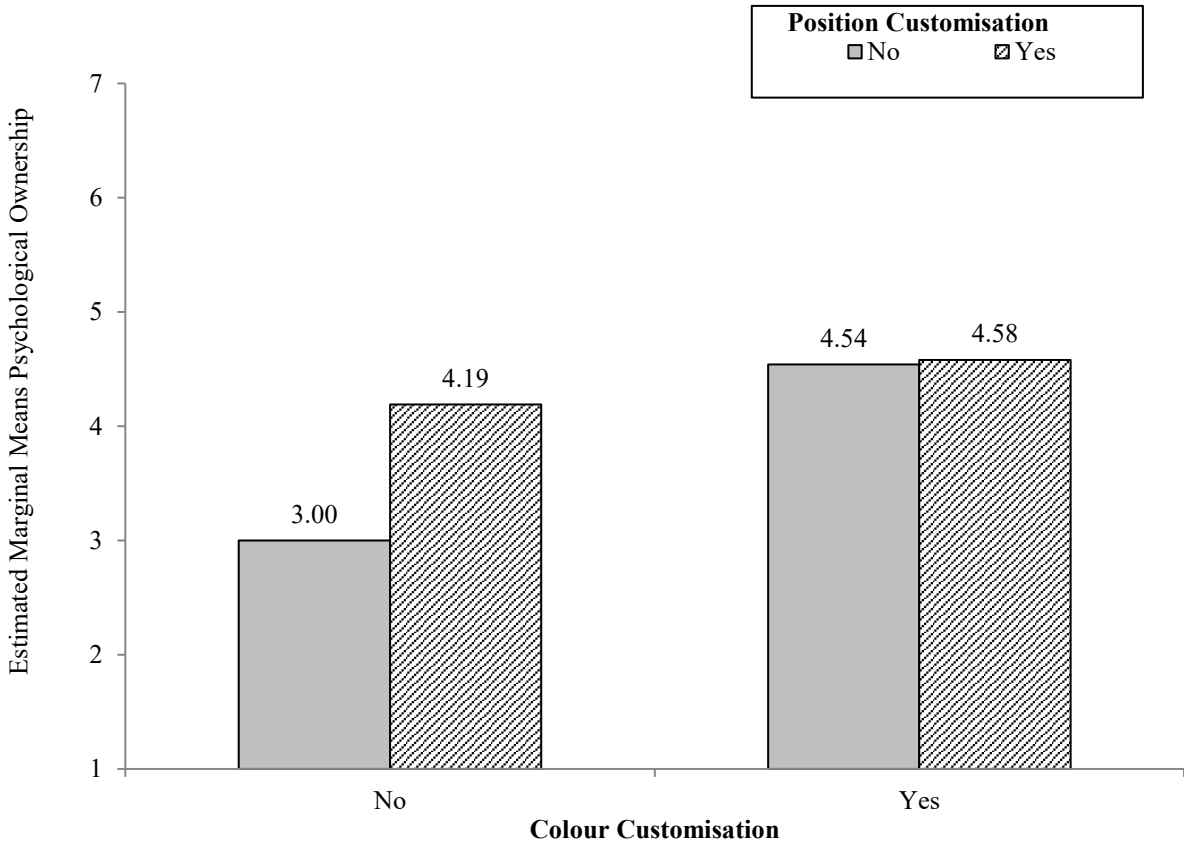

FIGURE 2. Interaction effect of colour and position customisation

Discussion

The results of Study 1 provide empirical evidence that customers, who spend as little as five minutes customising the colour and/or position of an AR hologram, experience a

heightened sense of psychological ownership of the digital product (H1). The results also reveal a possible ceiling effect, where each customisation affordance significantly increases psychological ownership, but combining different forms of customisation may only lead to marginal increases in their effects. While previous research has studied the evaluation of physical products with the help of AR content (e.g., Hilken et al., 2017), we investigate the customisation of AR holograms as products in their own right. In our research, however, customisation implies consequences beyond the embodied activity itself. In social settings, customisation likely allows customers to more readily adapt their social identity, which elevates perceptions of psychological ownership for AR holograms. We investigate this conjecture next[1].

STUDY 2

The purpose of Study 2 is to delve into the underlying processes of social adaptation that may drive the relationship between customers' shared experience of customisation (low vs. high) and sense of psychological ownership of AR holograms. In accordance with socially situated cognition theory, we argue that psychological ownership of AR holograms is driven by customers' needs for assimilation and differentiation within a social environment (Hamari and Lehdonvirta, 2010). We thus test H2, by which psychological ownership results from the unique ability to simultaneously satisfy these normally competing social needs. To achieve a shared experience, we constructed a social setting at its most basic level by randomly pairing participants in dyads (Paulus and Dzindolet, 1993; Crandall et al., 2008). This also allowed

[1] In our following studies, we account for the observed positive effects of colour and position customisation and their significant interaction effect on psychological ownership, by combining the manipulations to represent a high level of customisation in contrast to a no-customisation condition. This creates a natural comparison between customisable and non-customisable AR hologram. We next turn to an investigation of the underlying process by which the shared experience of customisation leads to a sense of psychological ownership of AR holograms.

us to ensure a balanced contribution of each participant to the interaction and avoid the intricate social dynamics that arise in larger groups (Andreoni, 1988).

Design and Procedure

90 undergraduate students (46 female and 44 male) between 18 and 32 years of age completed the experiment at a dedicated laboratory in exchange for a $10 gift card and a $5 cash show-up fee. We employed a two-factor (customisation: low vs. high) between-subjects design in a group setting of two participants at a time. That is, in each condition, two participants interacted with an AR hologram at the same time and were either allowed to both customise the hologram (high customisation) or were both not able to do so (low customisation). We expected greater variability of responses in the high customisation condition and therefore randomly assigned 60 participants to this condition, compared to 30 participants in the low customisation condition. Each participant was fitted with a personal HoloLens headset, and asked to interact with the same AR hologram of a yellow truck from Study 1. At the start of each interaction, we positioned the AR truck on a small white table in the centre of the laboratory where both participants using separate HoloLens headsets could see its location in the same position.

Participants in the high customisation condition were able to modify the AR truck using the Holostudio application. During a brief introduction, we provided participants with examples of how to customise the AR truck via the Holostudio toolbox including changing the colours of the AR truck as well as its size or position. In the low customisation condition, participants could not use the Holostudio toolbox. Instead, they interacted with the AR hologram by walking around the room to view it from different angles and could use objects in the room like chairs or whiteboard markers to explore how the AR hologram interacted with those physical objects. During the introduction, we provided these participants with examples of how AR holograms appear when viewed with the HoloLens headset. In the main

part of the study, participants interacted with each other and, depending on the condition, could or could not customise the AR hologram. This took on average five minutes, after which participants completed a questionnaire.

Measures

We used the 3-item psychological ownership measure (α = .92) from Study 1. We measured participants' sense of assimilation (α = .93) and differentiation (α = .77) with 3-item measures by Sheldon and Bettencourt (2002), respectively. Participants rated these items on a 7-point Likert scale ("Not at all" = 1 to "A substantial amount" = 7). We provide an overview of all items in Appendix C.

Results

Manipulation Check. To test the success of the customisation manipulation, we asked participants to rate a single-item measure ("Customisation allows users to manipulate an object's size, rotation, colour and position. Based on this definition, were you able to customise the car through the HoloLens?") on a 7-point bipolar scale ("I was not able to customise the truck" = 1 to "I was able to customise the truck" = 7). As intended, participants' ratings of customisation aligned with the customisation manipulation condition that they were assigned to (M_{High} = 6.22 vs. M_{Low} = 2.60, t(39) = -9.40, $p < 0.001$).

Social interaction. To ensure that participants perceived an authentic social setting, we also asked them to rate the extent to which they interacted with their partners on a single-item 7-point bipolar scale ("I did not interact with another participant" = 1 to "I interacted with another participant and discussed the object in depth with them" = 7). On average, participants believed that they considerably interacted with the other participant (M = 4.63 SD = 2.09). Furthermore, there was a significant effect of the ability to customise on the level of social interaction that participants shared (M_{High} = 5.47 vs. M_{Low} = 2.97, t(50) = -6.11, $p <$

0.001). This suggests that in social settings, customisation of AR holograms becomes a process of social coordination

Mediation analysis. We used the PROCESS macro (Hayes, 2012; Model 4) to test whether assimilation and differentiation, in parallel, mediated the effect of customisation on psychological ownership. This also allowed us to compare the relative strength of the indirect effects through these competing social needs. All regression results are reported in Table 1. We found a significant positive effect of customisation on assimilation (β = 0.87, p = 0.006) and differentiation (β = 0.94, p = 0.002). Furthermore, in support of parallel mediation, both assimilation (β = 0.33, p = 0.001) and differentiation (β = 0.38, $p < 0.001$) had positive effects on psychological ownership, while the direct effect of customisation no longer reached statistical significance (β = 0.50 p = 0.084). In further support of parallel mediation, bootstrapping for indirect effects with 5,000 samples revealed significant indirect effects from customisation to psychological ownership as the bias-corrected confidence intervals (CIs) excluded zero ($\beta_{\text{Assimilation}}$ = 0.28, 95% CI = 0.07 to 0.64; $\beta_{\text{Differentiation}}$ = 0.35, 95% CI = 0.11 to 0.77). We did not find any significant differences in the strength of the indirect effects ($\beta_{\beta\text{Assimilation} - \beta\text{Differentiation}}$ = -0.07, 95% CI = -0.50 to 0.34).

Discussion

Study 2 supports our conjecturing in H2 that psychological ownership is driven by social adaptation through different social identity needs. When accounted for simultaneously, the competing social identity needs of assimilation and differentiation fully mediate the process by which customers acquire psychological ownership of AR holograms in a social setting. These findings suggest that a unique affordance of an AR hologram, viewed through a device like the HoloLens, is that it allows customers to maintain social differentiation while at the same time allowing them to assimilate with peers. By customising an AR hologram together, customers may agree to compromise on some aspects, such as moving the AR truck

464 to a certain location or changing its chassis colour from yellow to blue, and as a result
465 experience a sense of ownership from assimilation. At the same time, when customers do not
466 agree on aspects of customisation or seek to express their individuality, AR also enables them
467 to experience a sense of ownership from personalising a digital product according to their
468 preferences. We next turn to an investigation of circumstances under which customers may
469 pursue either an assimilation- or differentiation-based path to psychological ownership (H3).
470
471 *STUDY 3*
472 The overall purpose of Study 3 is to explore whether customers, who extend their
473 experience with a shared versus personal AR device, bias cognitions about psychological
474 ownership of AR holograms on the basis of assimilation versus differentiation (H3a, H3b).
475 To provide a suitable extended exposure time, we introduced participants to AR holograms in
476 two phases. Phase 1 served to simulate an extended experience in using the AR technology.
477 Hopp and Gangadharbatla (2016) find that exposure times of at least 7 minutes are needed to
478 observe significant changes in attitude. We expect similar extended exposure times (i.e., on
479 average 15 minutes in our study) to help customers recognize the dominant affordances of the
480 AR device and shift their focus to either assimilation or differentiation, compared with a dual
481 focus during shorter exposure as anticipated in hypothesis H2 and Study 2. Moreover, phase
482 1 enabled us to rule out that novelty effects influenced our results. Product novelty is the
483 degree to which a product is unique or distinct compared to competing goods (Sethi and
484 Iqbal, 2008). Interaction with innovative, novel products typically leads customers to
485 experience higher levels of satisfaction and overall inflated responses to their experience.
486 In phase 2, we then tested H3a and H3b by manipulating customisation (low vs. high)
487 and the AR device type (personal vs. shared device). Our specific conjecturing in H3a is that
488 extended use of a personal AR device may bias customer expression of social identity needs

towards differentiation. In the unique case of AR holograms, this happens because differentiation is unobtrusive; even though customers can customise a shared AR hologram, they retain the ability to personalise aspects of the hologram without affecting how it appears to others. By introducing an extended use of a shared AR device, we are also able to explore H3b, by which customers may exclusively derive psychological ownership of AR holograms from assimilating with other customers during shared product experiences.

Design and Procedure

120 undergraduate students (69 female and 51 male), aged between 18 and 35, took part in Study 3 in exchange for a $20 cash payment (including a $5 show-up fee). We employed a 2 (customisation: low vs. high) x 2 (device type: personal vs. shared device) between-subjects factorial design. In the personal device condition, the customisation manipulation was equivalent to the one from Study 2. In the shared device condition, participants interacted using a single HoloLens headset and Microsoft Surface Pro Tablet, which alternated between the pair. While one person was wearing the headset, the other was able to see a live stream of the interaction through the HoloLens on a Microsoft Office Surface Pro Tablet.

Consistent with our previous studies, participants first received an introduction on how to use and calibrate the AR devices. Then, in phase 1, participants interacted with a different, custom-made, AR hologram of a grey passenger model car. Holostudio did not provide other cars in its database, so we developed a custom application. The application was natively coded for the HoloLens and presented participants a distinct AR model car. The AR car was a hatchback and differed from Holostudio's truck (see Appendix B). Participants in the high customisation condition were able to change the colour of the AR hatchback car to white, blue or charcoal, resize it to double or half its original size, rotate it through a 360-degrees towards the left or right, and slowly move the hatchback car around the room.

Participants remained in phase 1 until they indicated sufficient customisation of the AR hatchback car. On average this took 15 minutes, after which participants completed a questionnaire about their demographics. In phase 2, depending on the assigned condition, participants could (not) customise the AR hologram of the yellow truck used in the previous studies on the personal or shared AR device. They then completed the same questionnaire as in Study 2.

Measures

We used the same 3-item psychological ownership (α = .94), assimilation (α = .86) and differentiation scales (α = .86) as in our previous studies (Appendix C).

Results

Manipulation check. To assess whether our customisation manipulation worked as intended, we asked all participants to rate the same a single-item measure ("Customisation allows users to manipulate an object's size, rotation, colour and position. Based on this definition, were you able to customise the car through the HoloLens?") on a 7-point Likert scale ("Strongly disagree" = 1 to "Strongly agree" = 7). As intended, the rating of customisation experienced aligned with the customisation manipulation (M_{High} = 6.30 vs. M_{Low} = 2.88, t(90) = -13.16, $p < 0.001$)

Social interaction. We again measured the extent to which participants interacted with each other with a 7-point bipolar scale ("I did not interact with another participant" = 1 to "I interacted with another participant and discussed the object in depth with them" = 7). On average, participants believed that they considerably interacted with the other participant (M = 4.61, SD = 2.05). However, participants using a shared device interacted significantly more compared to those using a personal device (M_{Shared} = 5.81 vs. $M_{Personal}$ = 3.40, t(91) = -7.96, $p < 0.001$). These results are intuitive, as participants sharing a device must coordinate more and communicate about the AR hologram and its customisation.

Mediation analysis. To investigate H3a and H3b, we split the sample based on the device (shared or personal). We then used the PROCESS macro (Hayes, 2012; Model 4) to test separate mediation models with customisation as the independent variable, assimilation and differentiation as parallel mediators, and psychological ownership as the dependent variable. In the shared device condition (n = 60), customisation had a significant effect on assimilation (β = 0.99, p = 0.001) and differentiation (β = 0.78, p = 0.006). In support of H3a, assimilation predicted psychological ownership (β = 0.46, p = 0.016), whereas differentiation did not (β = 0.20, p = 0.304). The direct effect of customisation on psychological ownership remained significant (β = 1.92, p < 0.001). We used a bootstrapping procedure with 5,000 samples to test the assimilation pathway and found further support for H3a; the indirect effect was positive and the bias-corrected CIs excluded zero (β = 0.46, 95% CI = 0.07 to 0.64).

In the personal device condition (n = 60) customisation had a significant positive effect on differentiation (β = 1.23, p < 0.001) but not on assimilation (β = 0.31, p = 0.308), thus lending support to H3b. Differentiation, in turn, predicted psychological ownership (β = 0.38, p = 0.007), while the direct effect of customisation on psychological ownership remained significant (β = 1.06, p = 0.005). Bootstrapping with 5,000 samples for the differentiation pathway further supported H3b; the indirect effect was positive and the bias-corrected CIs excluded zero (β = 0.47, 95% CI = 0.13 to 1.04).

Discussion

In Study 3, we investigated how customers' extended use of different AR device types (personal vs. shared) may shape their expression of social identity needs and a resulting sense of psychological ownership. The results reveal that when participants interacted using a shared AR device, the assimilation pathway dominated (H3a) and when participants used a

563 personal AR device, differentiation was the dominant pathway (H3b) to psychological
564 ownership. These results are evident following phase 1 of the experiment where participants
565 interacted for an extended period with a different custom-made AR hologram of a model car.
566 By the time we introduced measurement in phase 2, participants were already familiar with
567 the HoloLens headset and had seen and customised AR holograms of model cars before.
568 Even though frequent use over time is beyond the scope of our research, the delayed
569 measurement in phase 2 was designed to both increase exposure and to counter an immediate
570 novelty effect within Study 3.

571

	Study 1	Study 2			Study 3 (shared device)			Study 3 (personal device)		
Dependent Variable	**Psychological Ownership†**	**Assimi-lation**	**Differen-tiation**	**Psychological Ownership**	**Assimi-lation**	**Differen-tiation**	**Psychological Ownership**	**Assimi-lation**	**Differen-tiation**	**Psychological Ownership**
Constant	-0.13 (0.61)	4.50 (0.25)***	3.59 (0.24)***	0.92 (0.53)***	4.43 (0.19)***	3.84 (0.16)***	-0.10 (1.03)	4.72 (0.21)***	4.04 (0.24)***	0.66 (0.75)
Colour x position customisation	-1.16 (0.47)*	-	-	-	-	-	-	-	-	-
Customisation		0.87 (0.31)**	0.94 (0.29)**	0.50 (0.29)	0.99 (0.29)**	0.78 (.27)**	1.92 (0.45)***	0.31 (0.30)	1.23 (0.33)***	1.06 (0.36)**
Assimilation	-	-	-	0.33 (0.10)**	-	-	0.46 (0.19)*	-	-	0.33 (0.15)*
Differentiation	-	-	-	0.38 (0.10)***	-	-	0.20 (0.20)	-	-	0.38 (0.14)**
R^2	0.39	0.08	0.11	0.38	0.17	0.13	0.57	0.02	0.19	0.45
MSE	1.49	1.90	1.69	1.42	1.24	1.09	1.58	1.37	1.66	1.55
F	18.12***	7.91**	10.44**	17.55***	11.38**	8.08**	26.63***	1.06	13.70***	15.35***
Df1	4	1	1	3	1	1	3	1	1	3
Df2	115	88	88	86	58	58	56	58	58	56

Coefficients with standard errors in parentheses *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
† Affect is included as a covariate in Study 1: ($\beta = .56$, $p < 0.001$).

572 *TABLE 1: Results of all studies*

GENERAL DISCUSSION

With growing investments and rapid improvements of AR devices, AR holograms have the potential to form a new class of digital products towards which, similar to physical products, customers may develop feelings of ownership. Such digitisation creates a unique challenge for managers looking to develop and implement AR solutions (Sinclair and Tinson, 2017). One aspect of this challenge is a distinct sense of psychological ownership of digital products compared with physical goods. The digitisation of products through AR holograms disrupts conventional aspects of ownership and requires a new understanding of psychological ownership, especially in light of AR's potential as a social technology. Our studies shed light on the phenomenon of psychological ownership as it relates to the shared experience of AR holograms, providing both theoretical insights into conceptualization and drivers of psychological ownership alongside insights into how to infuse customer-relevant perspectives with development and implementation of AR applications. As such, we also provide key areas for research and development for AR.

Theoretical Implications

As AR is increasingly deployed to enhance customers' shared experiences with digital products, it motivates a distinct conceptualisation of psychological ownership. Building on recent studies of psychological ownership in the context of digital interfaces (Brasel and Gips, 2014; Brengman et al., 2018; Hilken et al., 2017), and acknowledging the role of shared experience within group settings (Gineikiene et al., 2017; Pierce and Jussila, 2011), we propose a process by which the affordances of AR technology (i.e., customisation, shared experience, and device type) shape customers' psychological ownership of AR holograms. We establish a link between the affordances of AR and socially situated cognition theory. By describing these affordances in the context of psychological ownership, we extend marketing literature on psychological ownership of contemporary and emerging digital products,

specifically AR holograms. The conceptualisation of psychological ownership that we develop in this research extends conventional ideas of ownership (e.g., Peck and Shu, 2009; Pierce et al., 2003), since ownership of digital products is dependent on the dynamic transformation and sharing experience in settings where devices and social context shape customers' thoughts, feelings, and actions.

In this context, we are the first to describe how AR holograms drive a distinct interpretation of psychological ownership through customers' social identity needs. These include both the need to assimilate with others (Hamari and Lehdonvirta, 2010) and to express individuality by differentiating oneself from a group (Sheldon and Bettencourt, 2002). The fulfilment of these needs results in distinct parallel mediation mechanisms that underlie psychological ownership of AR holograms.

We empirically support our hypothesizing in a series of studies. In Study 1, we demonstrate that psychological ownership of AR holograms is possible. Our study shows how control over visual aspects of AR customisation (e.g., colour and position) can directly affect psychological ownership of AR holograms. This result extends literature on psychological ownership of intangible products and offers a valuable starting point to inform how potential marketing of AR holograms might be shaped.

We also provide a first empirical investigation of distributed cognitions through the shared experience of AR holograms, when customers interact in dyads to jointly customise an AR hologram. Due to the distributed nature of the AR experience, customers' social identity needs for assimilation and differentiation are activated and take over as the dominant processes to psychological ownership of AR holograms. By testing a parallel mediation in Study 2, we demonstrate that for short exposure periods simultaneous effects of assimilation *and* differentiation generate psychological ownership of AR holograms.

In Study 3, we highlight the role of embedded cognitions for AR, where we demonstrate that over time customers adapt their cognitive processing to the affordances of a device they use to experience shared AR holograms. On the one hand, our results suggest that the extended use of personal AR devices like HoloLens headsets promotes social differentiation by enabling a personal view of a shared AR hologram. On the other hand, we find that extended use of shared AR devices leads to assimilation between customers who jointly interact with an AR hologram. Taken together, these findings extend research on how customers may use AR to express their identity within a wider social context (Scholz and Smith, 2016).

Managerial Implications

Recognizing that technological applications are often criticized for not incorporating customer-relevant perspectives early enough (Dietrich et al., 2017), we seek to provide managers with potentially a novel perspective on AR that can inform development of customer-relevant offerings. To date, many AR applications have considered the technology as an add-on to the 'real' business of selling physical products and services. For instance, recent applications enable AR-based product trial of Ray Ban sunglasses, L'Oreal makeup, or IKEA furniture prior to online purchase (e.g., Hilken et al. 2017). However, we argue that the potential for AR to develop a wider set of offerings to customers has been underestimated. Few managers have thought of AR holograms as a distinct class of products. We offer an indication that AR holograms exhibit a necessary, even if not sufficient, condition to be considered a new class of products; namely a sense of psychological ownership.

Psychological ownership of AR holograms, we find, is distinct from conventional notions of ownership. In the past, many firms have struggled with marketing digital products (Berge et al., 2015), oftentimes because customers do not feel a conventional sense of ownership of highly customisable and shareable products (Gulotta et al., 2013). Thus many

managers have sought to inhibit the sharing of digital products, for instance through proprietary data formats or single user licenses. In contrast to these practices that are based on a conventional understanding of ownership, we demonstrate that enabling customers to modify and share AR holograms constitutes a key driver of psychological ownership. Accordingly, we advise managers to consider developing their digital AR offerings to offer shared experiences that are dynamic, easily transformable, and freely transferrable between customers.

Consistent with previous research (e.g., Scholz and Smith, 2016), we demonstrate that encouraging customers to use AR to express their identity is a key marketing objective. With public and private modes, AR lets customers fulfil their social identity needs depending on social context or occasion. On the one hand, customising AR holograms unobtrusively and in private may give rise to new forms of value creation that are unattainable through conventional physical marketing. Social differentiation from customising AR objects, for example, may enable roommates give the same apartment a different feel, couples forgo compromising on the interior design, and employees express their creativity by personalizing the standard office cubical whilst maintaining a professional appearance. On the other hand, supporting social assimilation by enabling shared public AR holograms is an opportunity for enhanced social interaction through highly visual communication.

Finally, although our findings suggest multiple paths to psychological ownership, we highlight that managers should be mindful of the devices through which they enable customers to modify and share AR holograms. Certain situations (e.g., being on the go vs. at home) may be more conducive to either shorter versus longer use of the technology or certain device types. Certain types of customers (e.g., younger vs. older customers; Grewal et al., 2018) may also find it more convenient to use a personal versus a shared device. In turn, some products may be inherently suited for fulfilling differentiation (e.g., abstract art pieces)

or assimilation needs (e.g., virtual toys). Our findings are an early indication of potential configurations of AR devices and customer needs to achieve a sense of psychological ownership of AR holograms.

Future Research and Application Development

To stimulate the development of AR in a customer-relevant manner, there is a need for future research on both the technological development and the understanding of shared customer experience of AR holograms. The findings and limitations of our studies point to fruitful opportunities for development in applications as well as supporting basic research.

First, in relation to the development of applications, we demonstrate the processes underlying a sense of ownership of AR holograms. By analogy, we assume that an expanded set of AR holograms may one day follow a similar process when AR holograms emulate functions of physical products. Yet, we only test a specific set of AR holograms in a laboratory setting. Future research should more directly investigate the substitution effect by AR holograms. Not unlike early digitisations of physical products at the dawn of the Internet age (e.g., music sharing), AR holograms may eventually redefine how customers interact with firms' products and services (Hilken et al., 2017). For example, an AR hologram of a model car as an aesthetic addition to a room might not only substitute a specific model of a car, but also may dynamically transform into a variety of different home décor products, such as a vase or a decorative flower. AR holograms release products from their physical form; thus, they might offer firms the ability to provide their customers with a multitude of products with similar functionalities. AR holograms could shift the marketing focus away from specific product attributes to the level of product affordances. An interesting extension from our findings is to consider the marketing and promotion of AR holograms. Research in this direction might uncover new approaches to marketing strategies, for instance by drawing on best practices for marketing products as a platform (Haigu and Altman, 2017). This shift

in research focus can also lead to an opportunity to redefine product portfolios along affordances and consider novel digital offerings.

Second, at the time of the study, HoloLens headsets were bulky, cumbersome to setup and calibrate, and rather low in social acceptance. These characteristics might have inevitably impeded social assimilation and differentiation, which might raise the question, to what extent our laboratory results would replicate in real customer contexts. The limitations of the technology limited our ability to achieve field studies. Nonetheless, there is a pressing need for research outside the laboratory, where social AR interactions can be studied unobtrusively. Overcoming the limitations of hardware is a matter of time, yet in principle AR is a prolific tool for customer research, alongside the aforementioned new customer offerings. Being personal, location specific, real-time, interactive, and data-rich it offers opportunities to study customer behaviour as never before. For instance, online companies routinely conduct experiments by presenting different versions of a website to randomly selected customers. With AR this ability for experimentation extends into the customer's physical environment.

Relatedly, it is important to study how social acceptance of AR gear and customer privacy concerns related to AR use will play an important role in shaping the future development of the technology. Some commentators raised privacy concerns as one reason for the early failure of AR platforms like Google Glass (Downes, 2013). Thus, research into privacy effects of AR holograms is highly relevant alongside the development of new product portfolios. Customers might be reluctant to consider AR holograms as a class of products if they feel that by using these products their information will be collected and used for marketing purposes.

Third, previous research has linked psychological ownership to value (Hilken et al., 2017) and willingness to pay (Plott and Zeiler, 2005). For managers, drivers of psychological

ownership are informative, but this begs the question of whether customers would pay for an AR hologram, on which factors this would depend, and how payment would affect the use of AR holograms? Whilst these questions are beyond the scope of our studies, they are important to establish in further research as a means of informing investment into and development of AR. Different customers may also be willing to pay more for AR holograms than others. We did not investigate customer heterogeneity, yet there are hints it might affect outcomes of technology interaction for example due to different (visual) processing styles (Childers, Houston and Heckler, 1985; Hilken et al., 2017). Due to the novelty of AR, there is little knowledge about pertinent customer characteristics that might affect psychological ownership of AR holograms. Further investigation of potential customer-related boundary conditions may be fruitful. For instance, we know customers process visual information differently (Bach et al., 2018), and visual biases can impede or enhance further feelings of psychological ownership (Nikander, Liikkanen and Laakso, 2014), which might in turn determine willingness to pay for AR holograms.

Alongside these applied development directions, there is also the need for further basic research. With limited time and budget, interactions with AR holograms in our laboratory were restricted to exposure times measured in minutes, though we were able to test the effects of more extended exposure times in Study 3 that are consistent with those in previous studies (e.g., Hopp and Gangadharbatla, 2016). This raises the question of whether psychological ownership of AR holograms persists over time. In this respect, it is interesting to investigate long periods of continuous AR use (cf. Scholz and Duffy, 2018) as well as repeated exposures to AR holograms. Currently, we do not fully understand either of these boundary conditions. However, there are reasons to think psychological ownership may persist over the long-term. For example, Apples' ARKit provides functionality to save the location of AR holograms, so when customers return to a location, the AR holograms are

where they left them (Engadget, 2018; Apple Newsroom, 2018). We also argue for the low cost, and the dynamic nature of customisation that enhances the sense of psychological ownership of AR holograms. Yet little is known about the interplay of simulated permanence (like that enabled by the Apple's ARKit) and the dynamics of customisation. It is likely that both contribute to psychological ownership in different ways for different customers. Investigating boundary conditions to such effects may uncover novel insights about customer behaviours. We see a hint of this in Study 3, where the process towards psychological ownership of AR holograms differed from that in Study 2. Specifically, extended shared experience of AR holograms during phase 1 of Study 3 intensified the expression of social identity needs in phase 2. It is likely, as customers use AR more frequently, they will adapt to the technology in novel ways that spur further research interest.

Boundary conditions may also include functionalities of AR holograms. For example, a primary function of a washing machine cannot be replicated with an AR hologram. AR holograms suit visual and aesthetic aspects of products. Whilst there are obvious applications like home decoration or TV sets, we can also see the emergence of new products that take advantage of inherent dynamics of AR holograms. AR brands able to respond to customer behaviour may become imbued with actual personalities (Aaker, 1999) creating a new layer of value. In this respect, the scope of our current research is seminal.

Finally, we simulated social interaction at its most basic level with two participants per group. Yet, more complex social dynamics are possible. Dyads themselves might differ in many ways. Future research could investigate whether familiarity amongst participants affects their sense of shared experience or psychological ownership, natural contexts help or hinder the expression of social identity, and private (e.g., a customer's home) versus public spaces (e.g., retail shop) are important to the dynamics of shared AR experience.

Conclusion

AR holograms are emerging as a potentially new class of digital products. Their unique affordances challenge conventional configurations of product ownership calibrated for physical settings. The distinct nature of psychological ownership of AR holograms offers a glimpse of a new marketing frontier, one predicated on dynamics of socially situated interactions and evolving affordances of the AR technology. Managers steeped in a world of physical products, may take heed of an exponential progress in AR digitisations, which, whilst imperceptible at the beginning, within a few generations of a digital technology might become commonplace.

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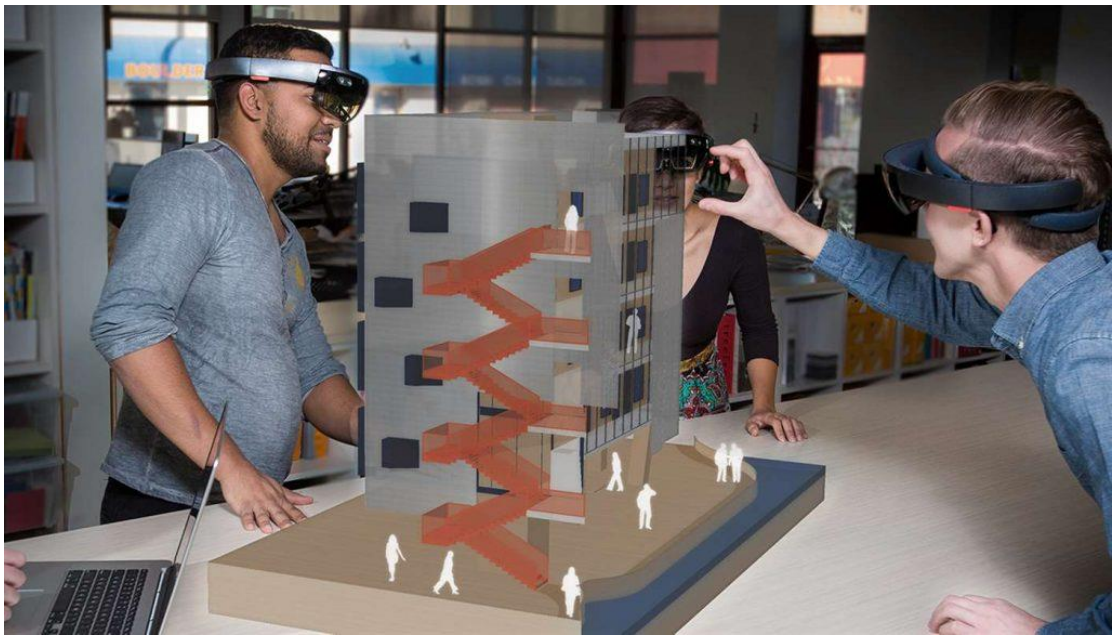
APPENDIX A: The Microsoft Office HoloLens

Through the HoloLens you can watch your preferred television station alone or in a group setting, view real-time weather reports and your to-do list for the day.

Turn your living room into a game!

This device can be connected with your team to view a new project in 3D and the ease of customisation allows adjustments to be simply made to the prototype.



APPENDIX B: EXPERIMENTAL STIMULI

Holostudio App: Virtual Truck

Developed App: Virtual Car

Experimental Design: Study 3

Group	Phase 1 (Developed App)	Phase 2 (Holostudio App)
	Personal device	**Shared device**
A	Customise	No customisation
B	No customisation	Customise
	Shared device	**Personal device**
C	Customise	No customisation
D	No customisation	Customise

APPENDIX C: Measurements

Psychological Ownership (adapted from Peck and Shu, 2009)

Studies 1, 2 & 3

Please rate the extent that you experience the following.

1. I feel like this is my truck
2. I feel a very high degree of personal ownership of the truck
3. I feel like I own this truck

[7-point Likert scale ("Strongly disagree" = 1 to "Strongly agree" = 7)]

Affect (adapted from Kim et al., 1996)

Study 1

Please rate your feelings towards the object after your customisation.

1. Unpleasant → Pleasant
2. Dislike very much → Like very much
3. Left me with a bad feeling → Left me with a good feeling

[7-point bipolar scale]

Customisation manipulation check

Study 1

Please rate the following scale in relation to your experience interacting with the virtual truck.

1. I was able to personalise the truck to suit my preference (Colour manipulation)
2. I had control over the truck (Position manipulation)

[7-point Likert scale ("Strongly disagree" = 1 to "Strongly agree" = 7)]

Studies 2 & 3

Customisation allows users to manipulate an object's size, rotation, colour and position. Based on this definition, were you able to customise the car through the HoloLens? [7-point bipolar scale ("I was not able to customise the truck" = 1 to "I was able to customise the truck" = 7)]

Assimilation (adapted from Sheldon and Bettencourt, 2002)

Studies 2 & 3

Please rate your experience when interacting with the other individual and virtual truck.

1. How included did you feel in this setting?
2. To what extent do you feel well integrated into this setting?
3. To what extent do you feel a sense of belongingness?

[7-point Likert scale ("Not at all" = 1 to "A substantial amount" = 7)]

Differentiation (adapted from Sheldon and Bettencourt, 2002)

Studies 2 & 3

Please rate your experience when interacting with the other individual and virtual truck.

1. How much do you feel like you stood out compared to the group?
2. How unique did you feel as you participated with the group?
3. How distinct and separate did you feel with the group?

[7-point Likert scale ("Not at all" = 1 to "A substantial amount" = 7)]

Social interaction

Studies 2 & 3

Please rate the extent that you interacted with the other participant.

[7-point bipolar scale ("I did not interact with another participant" = 1 to "I interacted with another participant and discussed the object in depth with them" = 7)]

Demographics

Studies 1, 2 & 3

What is your primary language?

What is your nationality?

What is your age? (in years)

What is your gender?